केन्द्रीय भूमिजल बोर्ड

जल शक्ति मंत्रालय, जल संसाधन, नदी विकास और गंगा संरक्षण विभाग

भारत सरकार

Central Ground Water Board

Ministry of Jal Shakti,
Department of Water Resources, River Development
and Ganga Rejuvenation
Government of India

Report on

AQUIFER MAPPING AND MANAGEMENT PLAN

Mandya Taluk, Mandya District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

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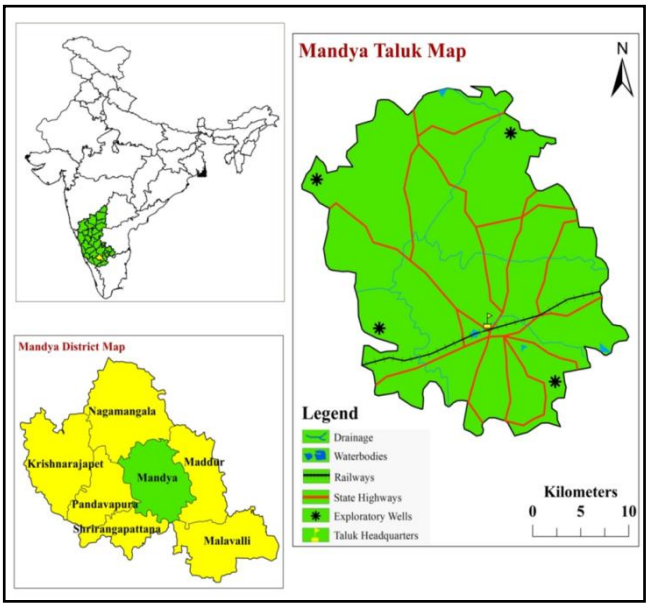
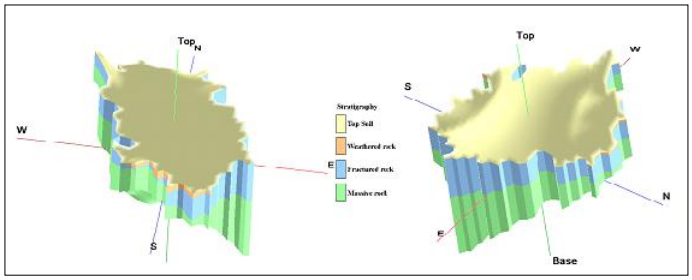
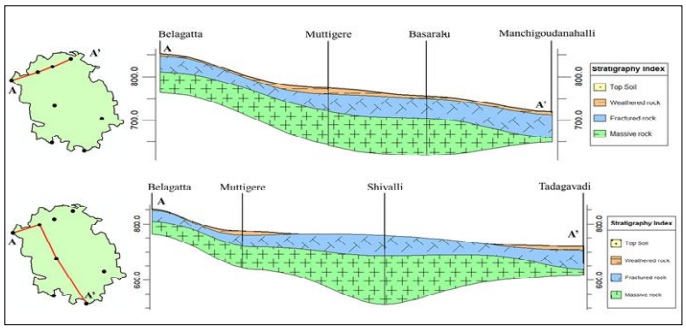
AQUIFER MAPS AND MANAGEMENT PLAN, MANDYA TALUK, MANDYA DISTRICT, KARNATAKA STATE

(AAP: – 2021-2022)







By

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SEPTEMBER 2022

AQUIFER MAPS AND MANAGEMENT PLAN, MANDYA TALUK, MANDYA DISTRICT, KARNATAKA STATE

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AQUIFER MAPS AND MANAGEMENT PLAN, MANDYA TALUK, MANDYA DISTRICT, KARNATAKA STATE

1. SALIENT INFORMATION

Name of the taluk: Mandya

District: Mandya

State: Karnataka

Area: **711**sq.km.

Population: 4,15,153 (2011 census)

Normal Rainfall: 737 mm

1.1 Study area

Aquifer mapping studies were carried out in Mandya taluk, Mandya district of Karnataka, covering an area of 711 sq.km under NAQUIM Project during the AAP 2020-21. Mandya taluk of Mandya district is located between north latitude 12°26' 29.04" to 12°45'1.08"and East longitudes 76°42'34.2" to 77°0'39.24". Mandya taluk is bounded by Nagamangala taluk in north, Maddu rtaluk in east, Srirangapatna taluk of Mysore district in south and Pandavapura taluk in the west. Administratively Mandya taluk is divided into 5 Hoblies, 46 Panchayats (http://panchamitra.kar.nic.in), 183 villages (http://e-krishiuasb.karnataka.gov.in). Location map of Mandya taluk of Mandya district is presented in **Fig.1.**

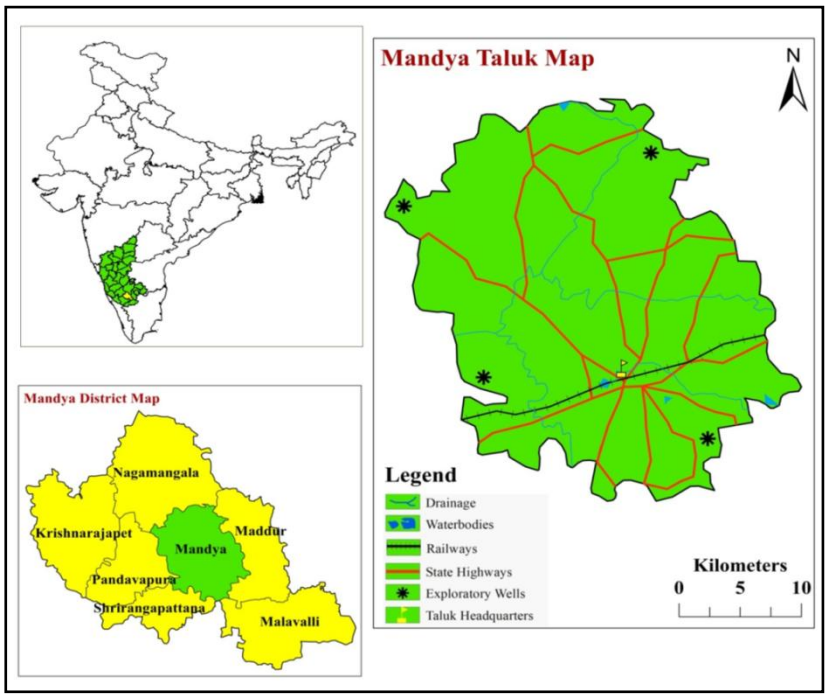

Fig.1: Location map

1.2 Population

According to 2011 Census of India, the total population of Mandya taluk is 4,15,153 of which 208,607 are males and 206,546 are females. 33.1% people lives in urban areas while 66.9% lives in the rural areas. The average literacy rate in urban areas is 85.3% while that in the rural areas is 69.6%. The total literacy rate of Mandya Taluk is 74.75%.The male literacy rate is 73.28% and the female literacy rate is 61.63%.

1.3 Rainfall

The rainfall of the Mandya is accounted by the Pre-monsoon (PRE) months, SW monsoon (SWM) months and NE monsoon (NEM) months. Bulk of the rainfall is contributed by SW Monsoon i.e., during June to September. In general, humid to semi-arid climatic conditions prevail in the area. The Normal rainfall data (1951 to 2000) is **737** mm. The Actual and Normal rainfall of Mandya taluk from 2016 to 2019 & Season wise rainfall of 2020is given in **Table.1 and Table.2**.

Table 1: Actual and Normal rainfall of Mandya taluk from 2016 to 2019

Normal(mm)	2016		2017		2018		2019	
	Actual (mm)	% Dep	Actual (mm)	% Dep	Actual (mm)	% Dep	Actual (mm)	% Dep
795	516	-35	941	18	715	-10	804	1

Source; KSNDMC, Karnataka

Table 2: Rainfall (mm) of Mandya Taluk during 2020

Premonsoon (Jan-May)			SW monsoon (Jun-Sep)			NE monsoon (Oct-Dec)			Annual (Jan-Dec)		
Normal	Actual	% of Departure	Normal	Actual	% of Departure	Normal	Actual	% of Departure	Normal	Actual	% of Departur
166	**229**	**38**	**316**	**372**	**18**	**217**	**219**	**1**	**699**	**820**	**17**

Source; KSNDMC, Karnataka

1.4 Agriculture& Irrigation

Agriculture is the main occupation in Mandya taluk. 92 % of the total population constitutes the rural population. The amount of rainfall and its distribution throughout the season contributes to the cropping pattern in the area. There are two agricultural seasons namely Kharif (June to October) and Rabi season (Mid October to Mid-February). Major Kharif crops are paddy and vegetables. Maincrops of Rabi season are pulses and oilseeds. Fruits and vegetables are the other crops grown **(Table 3).** Example of the Paddy and Sugarcane cultivation is shown in **Photo.1.**

Table 3: Area wise crops grown in Mandya Taluk

Sl.No	Name of Crop	Area in Ha(2014-15)
1	Paddy	15669
2	Sugarcane	9760
3	Jowar	127
4	Ragi	6232
5	Maize	547
6	Pulses	4296
7	Oilseeds	248
8	Total Fruits &Vegetables	1348

Source: District at a glance 2015 - 16, Govt. of Karnataka

Photo-1.Paddy and Sugarcane cultivation in Mandya taluk

During the year 2015 – 16, percentage of gross sown area of total geographical area was 60% and net sown area was 47% in the taluk (**Table4)**. Land use map of Mandya Taluk is shown in **Fig.2.**

Table 4: Land use pattern in MandyaTaluk

Total Geographical Area (ha)	Area under Forest (ha)	Area not available for cultivation (ha)	Other Cultivable land(ha)	Fallow land (ha)	Net sown area (ha)	Area sown more than once (ha)
71512	1507	13585	6345	16807	33268	9459

Source: District at a glance 2015 - 16, Govt. of Karnataka

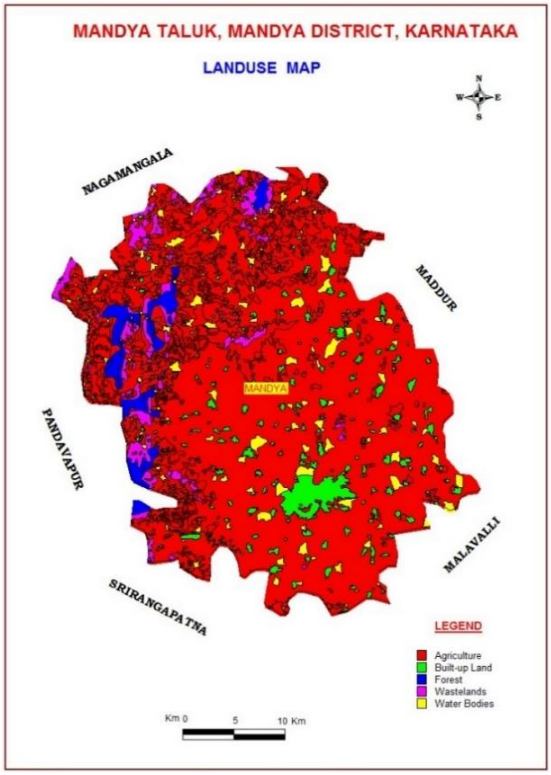

Fig.2: Landuse map

Mandya taluk is marked by a series of tanks varying in size from small ponds to considerably large tanks. Gross irrigated area by borewells is **3186** ha and net irrigated area is 2411ha (**Table 5**). Gross irrigated area by all structures in the taluk is 31417 ha and net irrigated area is 28148 ha. The dug well irrigation practice in the taluk is shown in **Photo.2**

Table 5: Irrigation sources in Mandya Taluk

Sl. No.	Irrigation source	Area / Nos	Net area irrigated (Ha)
1	Canal	44.8 km length/	21931
2	Tanks	/95	2520
3	Wells	/2024	1245
4	Bore Well	/4180	2411
5	Lift Irrigation	-	-
6	Other Sources	-	41
	Total		**28148**

Source: District at a glance 2015 - 16, Govt. of Karnataka

Pumping dugwell used for irrigation

1.5 Geomorphology, Physiography & Drainage

Mandya taluk represents an uneven landscape with intermingling of hills and valleys. Geomorphology map of the taluk is shown in **Fig.3.**

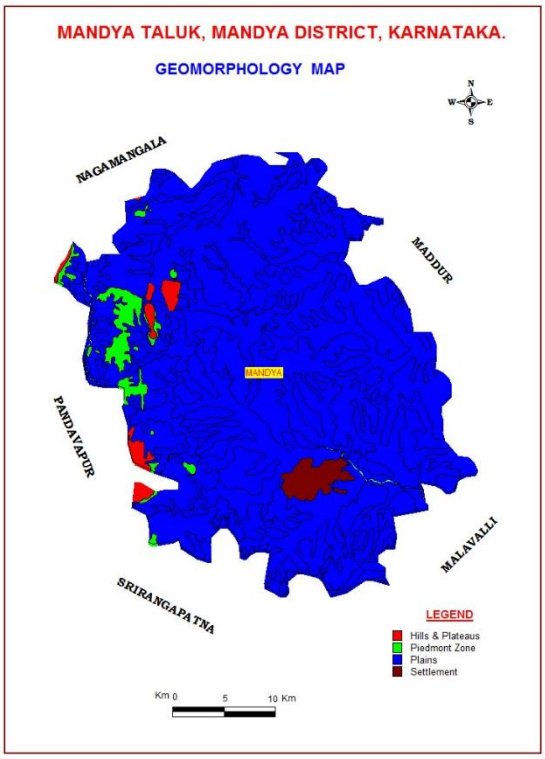

Fig 3: Geomorphology Map

Mandya taluk drains by Cauvery and its tributaries. Drainage pattern is dendritic to sub dendritic. The drainage map of the study area is presented in **Fig.4**.

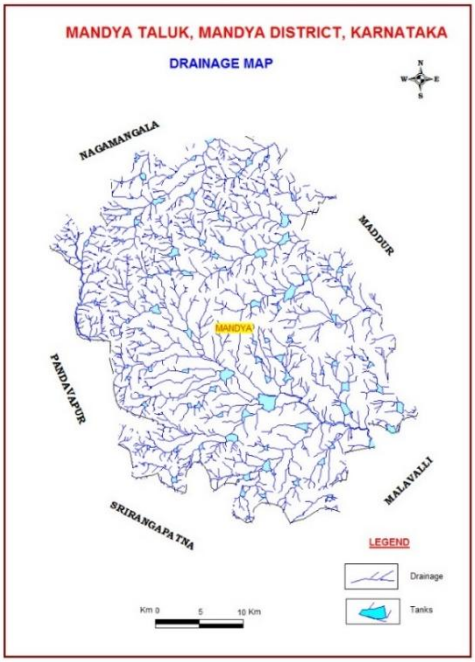

Fig 4: Drainage Map

1.6 Soil

The soil of Mandya taluk range from red sandy loam to red clay loam, very thin in ridges and higher elevations and comparatively thick in valley portions. The soils in Mandya taluk are thin gravelly and underlain with a zone containing weathered rock. The soils are highly leached and poor in bases. The water holding capacity is low (**Fig.5**).

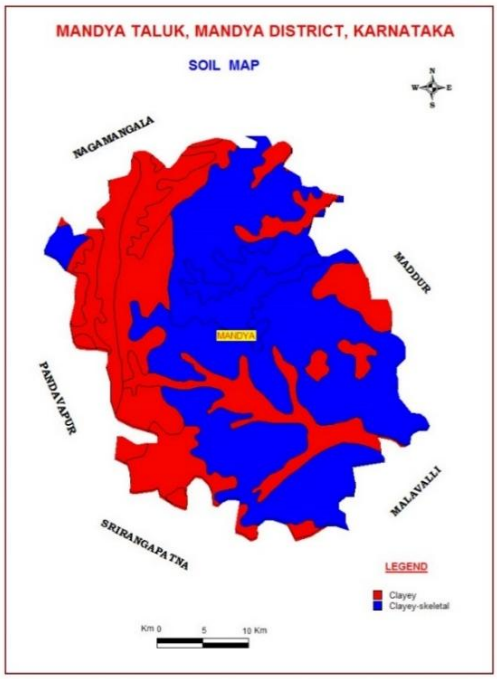

Fig 5: Soil Map

1.7 Groundwater resource availability and extraction

Aquifer wise total ground water resources up to 200 m depth are given in **Table-6** below.

Table.6: Total GW Resources (2017) (Ham)

Taluk	Annual Replenish able GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (Down to 200m)	Dynamic +Fresh in-storage
Mandya	11242	3595	1039	15877

1.8 Existing and future water demands (as per GEC- 2017)

- Net groundwater availability for future irrigation development:5980 MCM
- Domestic (Industrial sector) demand for next 25 years: 773 MCM

1.9 Hydrogeology

Aquifer I - The weathered thickness ranges from 8 to 20 m. The premonsoon depth to water level in National Hydrograph Stations (NHS) ranges from 2 to 5 mbgl. Aquifers are not sustainable for longer duration pumping and becomes de-saturated.

Aquifer II - The major formations are fractured Granites and Gneisses. The pre-monsoon piezometric head ranges from 15 to 45mbgl. The yield of the fractured aquifer ranges from 0.5 to 1.2m^3/hr and sustainability is less than 1 hour. The hydrogeology map of the Mandya taluk is shown in **Fig.6.**

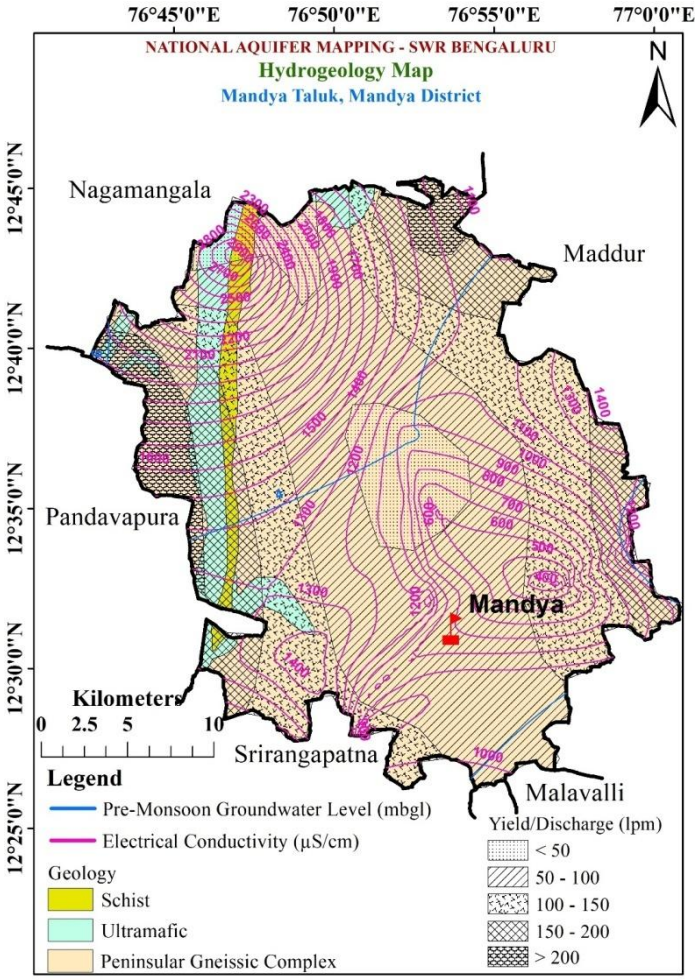

Fig 6: Hydrogeology map

1.10 Water level behavior

(a) Depth to water level

Aquifer – I (Phreatic)

- Pre-monsoon: 2.05- 4.9 mbgl **(Fig.7)**
- Post-monsoon: 1.80 - 9.80 mbgl **(Fig.8)**

The depth to water level data of the monitoring wells of State Ground water Department and CGWB from 2011 to 2020 is given in the following **Table7**.

Table 7: Depth to WL data of the Monitoring wells of GWD & CGWB from 2011 to 2020

Agency (CGWB/ GWD)	Location	Well type(Bore/ Dug well)	Latitude (in decimals)	Longitude (in decimals)	Depth to water level (mbgl)																					
					May-11	May-12	May-13	May-14	May-15	May-16	May-17	May-18	May-19	May-20	Nov-11	Nov-12	Nov-13	Nov-14	Nov-15	Nov-16	Nov-17	Nov-18	Nov-19	Nov-20	Premonsoon Decadal average (May 2011-May 2020)	Postmonsoon Decadal average (Nov 2011-Nov 2020)
GWD	Baby	Dugwell	12.68	76.85	4.17	5.44	7.32	4.00	5.10	8.70						5.77	4.00	0.90	5.10						5.53	3.57
GWD	Bevakal	Dugwell	12.61	76.78	10.20	12.35			12.10						9.88			12.10							9.23	8.32
GWD	Bilidegilu	Dugwell	12.62	76.87	3.40	3.40	3.48		2.30	5.01	5.43	2.25	4.05		3.91	3.90	4.11	1.80	0.90	3.13	2.70	2.87	2.01		3.55	2.72
GWD	Madechakanahalli	Dugwell	12.56	76.80	2.91	3.73		5.10	2.65	3.00					3.06	3.70	2.85	4.05	3.07	5.58					3.48	3.57
GWD	Pura	Dugwell	12.48	76.93	7.29										6.59	6.56	5.70	7.18							6.73	6.41
GWD	Budanur	Borewell	12.55	76.95	5.42		12.20	5.90	5.60	7.00	17.45	8.91	6.85		4.44	5.57	3.80	3.75	5.02	7.86	5.10	4.58	3.85		8.34	4.72
GWD	Mandya	Borewell	12.52	76.89	7.10	6.61	13.40			8.10	9.70	7.96	7.50		5.75	8.89	7.50			9.13	4.90	5.08	4.20		8.53	6.27
GWD	Tubinakere	Borewell	12.50	76.80	15.28	4.80		24.65	15.70	14.90	16.60	12.80	19.26		17.42		22.10	13.95	15.20	16.33	7.10	14.03	13.00		17.20	15.11
GWD	Bevakal	Borewell	12.60	76.78			1.43	16.45		18.23	20.15	15.89					7.50	15.50		18.46	8.10	15.23			14.43	12.96
GWD	Baby	Borewell	12.68	76.85	11.70	11.70	9.30			16.89	16.60	8.07	15.70		15.60	15.60	11.10			15.05	8.00	9.91	11.11		12.13	11.18
GWD	Javanahalli	Borewell	12.64	76.74	8.69	8.85	11.14	18.50	10.88	13.00	15.14	10.60	14.36		8.37	8.79	8.90	17.10	10.10	13.33	6.30	10.63	6.22		12.12	9.46
GWD	Pura	Borewell	12.48	76.94	2.91	3.73	19.70	9.40		9.60	26.50	8.02	8.80		3.06	3.70	3.75	8.65		7.47	4.80	6.06	5.60		10.46	5.24
CGWB	Basaralu	Dugwell	78.78	12.71	1.46	1.98	9.40	9.30	4.04	8.20	11.10	4.27	6.67	4.90	1.62	3.98	6.83	3.65	3.60	8.30		2.45	3.38		5.72	3.83
CGWB	Besegarahalli Cross	Dugwell	76.98	12.63				7.00	5.43	8.73	6.30						4.02		2.18	6.58	2.19	4.75	6.13	4.03	6.87	4.27
CGWB	G.Kundipatna	Dugwell	76.88	12.59			7.25	0.90	2.60	7.60	2.39	3.38	1.43	7.05			0.81	0.59	2.43	2.32	1.31	2.80	2.15	0.60	4.08	1.63
CGWB	Gopalapura	Dugwell	76.88	12.55			5.40	5.20	1.80	7.80	7.80	7.80					4.91	4.95	2.81	7.80	5.55	4.48	2.62	3.12	5.97	4.53
CGWB	HaleBudanur	Dugwell	76.95	12.54	5.25	6.20	7.73	6.78	4.85	6.15	8.25	5.68	7.10	5.10	3.35	4.60	3.80	3.95	2.80	7.17	5.38	3.88	4.75	3.00	6.26	4.09
CGWB	Kallahallimandya	Dugwell	76.86	12.50					2.28	3.06	5.27	2.72	3.90	2.20				1.78	1.59	3.30	2.05	2.58	3.08	2.26	3.24	2.38
CGWB	MandyaDw	Dugwell	76.89	12.53					3.10	2.40	1.82	1.35	2.80						1.62	4.05	2.35	1.95	3.00		2.29	2.59
CGWB	Mandya2	Dugwell	76.83	12.50	1.68	1.36									1.57	1.42									1.60	1.32
CGWB	Sundahalli	Dugwell	76.83	12.50			5.88	3.26	0.52	5.07	6.27	3.41	3.06	2.22			1.68	1.57	2.53	3.40	2.42	2.87		3.25	3.71	2.53
CGWB	Yaliyur	Dugwell	76.83	12.51			12.50	2.66		12.50	12.50	3.08	3.16	1.34			1.90	1.79	2.10	3.15	3.10	2.75	2.65		6.82	2.49

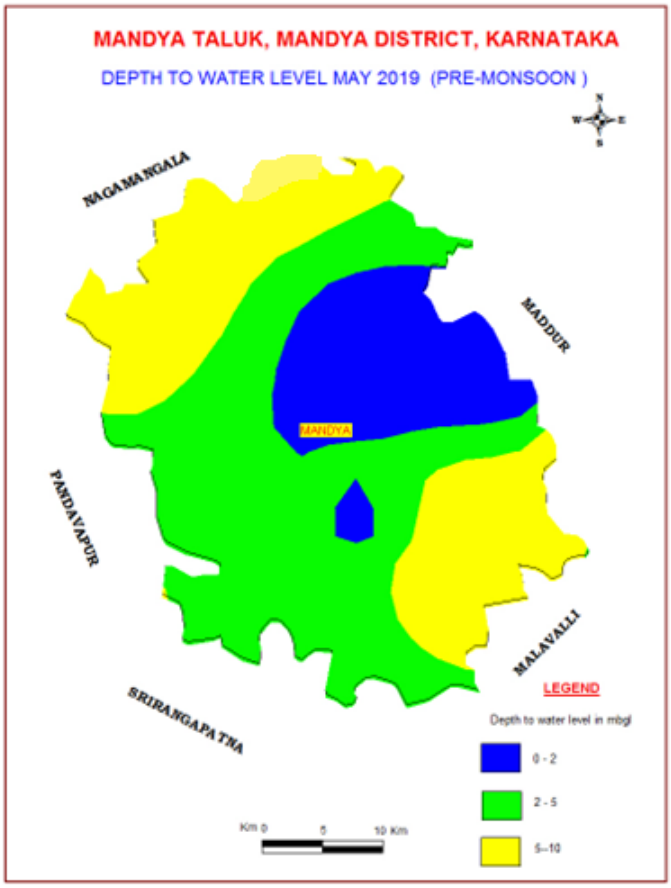

Fig. 7:Pre-monsoon DTW (May 2019)

Fig. 8: Post-monsoon DTW (Nov 2020)

Seasonal water level fluctuation map of phreatic aquifer during May & November 2019 is shown in **Fig. 9.**The Decadal Fluctuation Map of Phreatic aquifer (Aquifer-1) from 2010 to 2019 is shown in **Fig. 10**and the values are shown in **Table 8.**

Table 8: Long Term Ground Water Level Trend (2011 to 2020)

SLNO	LOCATION	PRE-MONSOON		POST MONSOON	
		Rise (m/year)	Fall (m/year)	Rise (m/year)	Fall (m/year)
1	Basaralu		0.547		0.2217
2	Bilidegilu	0.0219			0.0966
3	G.Kundipatna	0.4474			0.0754
4	Hale Budanur		0.1119		0.1207
5	Sundahalli	0.0848			0.2239
6	Besegarahalli Cross				0.1795
7	Gopalapura			0.2513	
8	Kallahallimandya				0.0616
9	Yaliyur				0.182

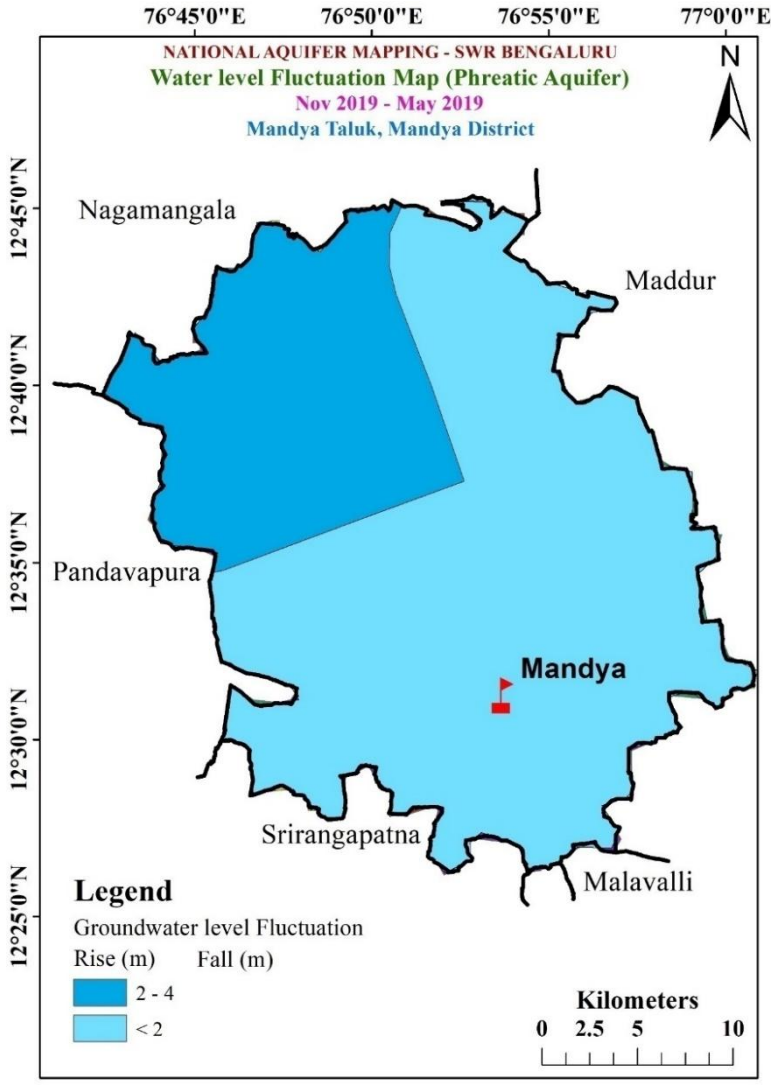

Fig. 9: Seasonal Water level fluctuation (Nov 2019- May 2019)

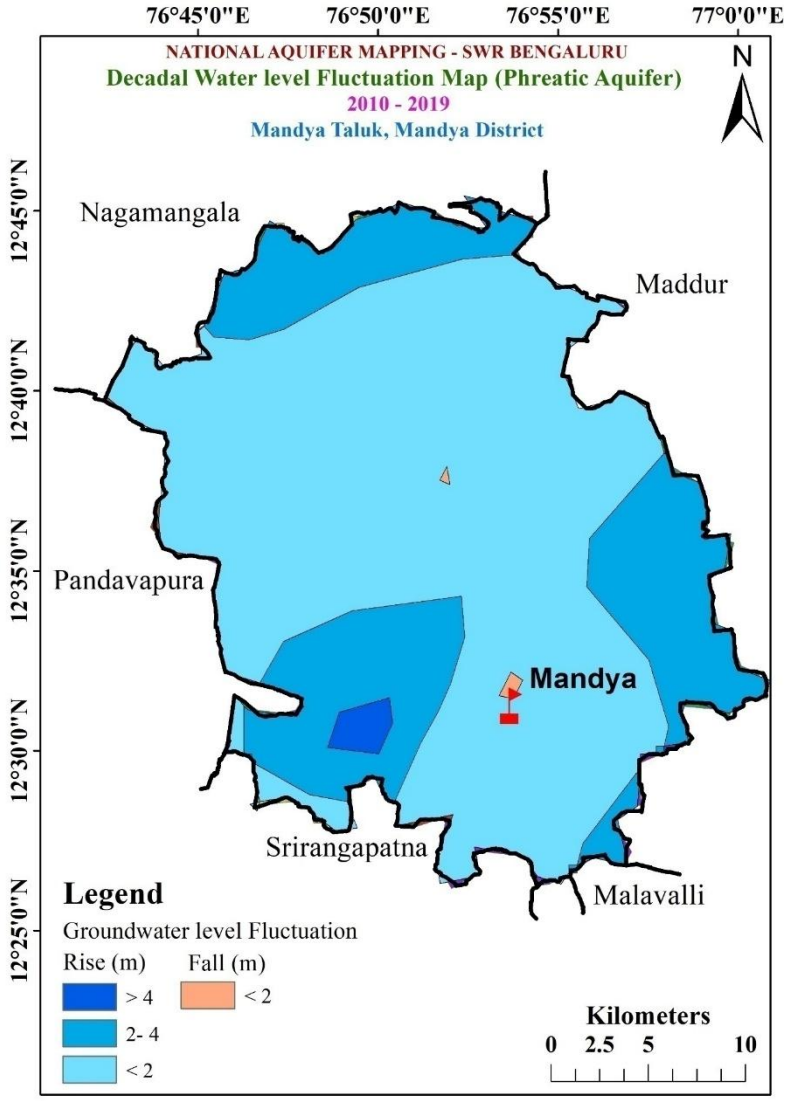

Fig. 10: Decadal Fluctuation Map of Phreatic aquifer

2. AQUIFER DISPOSITION

2.1 Aquifer types

In Mandya taluk, there are two types of aquifer systems

i. Aquifer-I (Phreatic aquifer) comprising weathered Granite and banded gneissic complex

ii. Aquifer-II (Fractured aquifer) comprising Fractured Granite and Banded gneissic complex

Geologically, Mandya taluk is predominantly underlain by granites and gneisses of Archaean age, popularly designated as hard rocks. These gneisses are often found to be intruded by basic dykes. The dominant strike direction is northwest– southeast.These hard rocks are fractured and fissured, and have undergone extensive and chemical decomposition in the plains and valleys. The resulting weathered mantle ranges inthickness generally from 8 to 20 meters.

In Mandya taluk, fractured granite and gneiss are the major water bearing formations **(Fig.11)**. Groundwater occurs within the jointed and fractured Granite and Gneiss under semi-confined to confined conditions. 6 Exploratory borewells were drilled in this taluk by CGWB from a minimum depth of 65mbgl to a maximum of 202mbgl.Depth of weathered zone (Aquifer-I) ranges

from 8mbgl to 20mbgl **(Fig.12)**.Ground water exploration reveals that aquifer-II fractured formation was encountered between the depth of 30 to 180mbgl. Yield is low to medium and ranges from 0.05to 5 lps. The details of the Exploratory wells drilled by CGWB are given in **Table 9.**

The 2D aquifer sections, 3D Aquifer disposition and 3D Aquifer Fence diagrams have been prepared and presented in **Fig. 13(a), 13(b) and 13(c).**

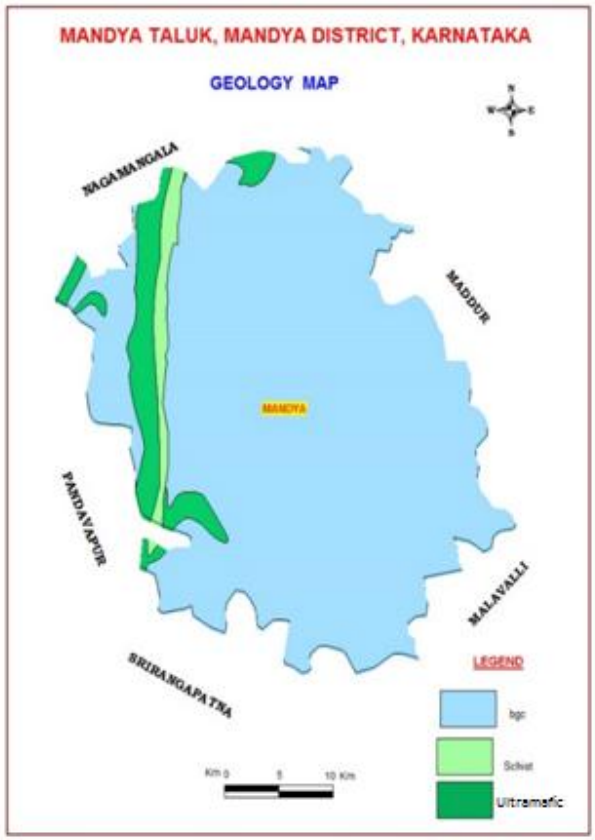

Fig.11: Geology Map

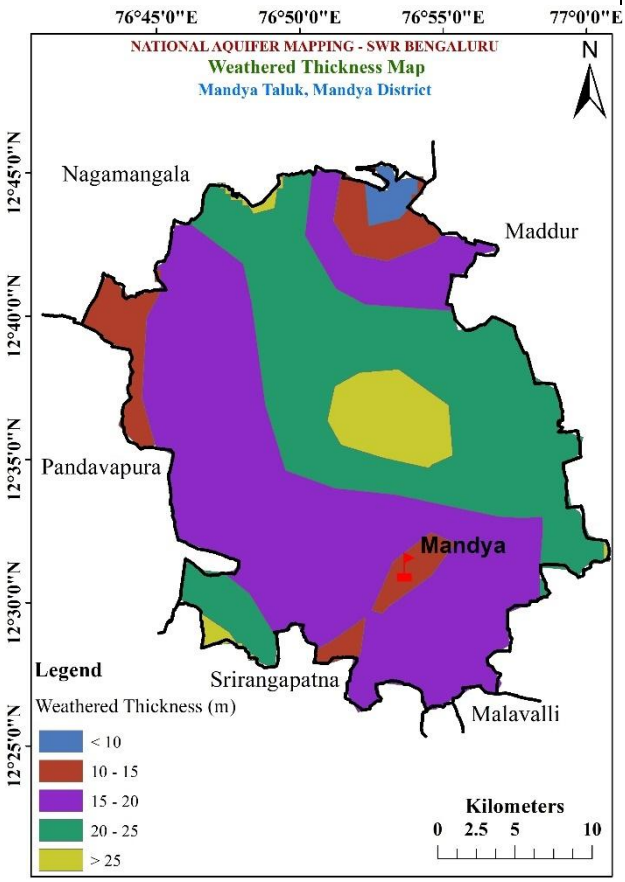

Fig. 12: Weathered thickness Map

Table 9: Details of Ground water Exploration in Mandya Taluk

Sl.no	Location	Coordinates	Depth (m)	Casing	Fracture zones	Discharge lps	SWL	DD	T m^2/day	SLpm/ mdd	Formation
1	Shivalli	12˚ 34’55” : 76˚ 49’ 35”	200	20.35		1.3	7.76	36.36	0.823	2.15	Granite gneiss
2	Basaralu	12˚ 42’25” : 76˚ 49’ 15”	200	24		0.611	4.12	45.94	0.276	0.8	Granite gneiss
3	Manchigouda nahalli	12˚ 43’55” : 76˚ 52’ 15”	65.55	7.4	6.5,15.75,23.8,31.4,45-46.51,3.60	4		6.93			Granite gneiss
4	Manchigouda nahalli	12˚ 42’25” : 76˚ 49’ 15”	77.35	6.4	9.7-14,22-30,55,64,68	4.3		3.25	34		Granite gneiss
5	Muttigere	12˚ 41’20” : 76˚ 46’ 50”	90	16.5	19.80,39,90	1.45		23.63			Granite gneiss
6	Halebudanuru	12˚ 52’30.4” : 76˚ 57’ 52.8”	202.3	18.8							

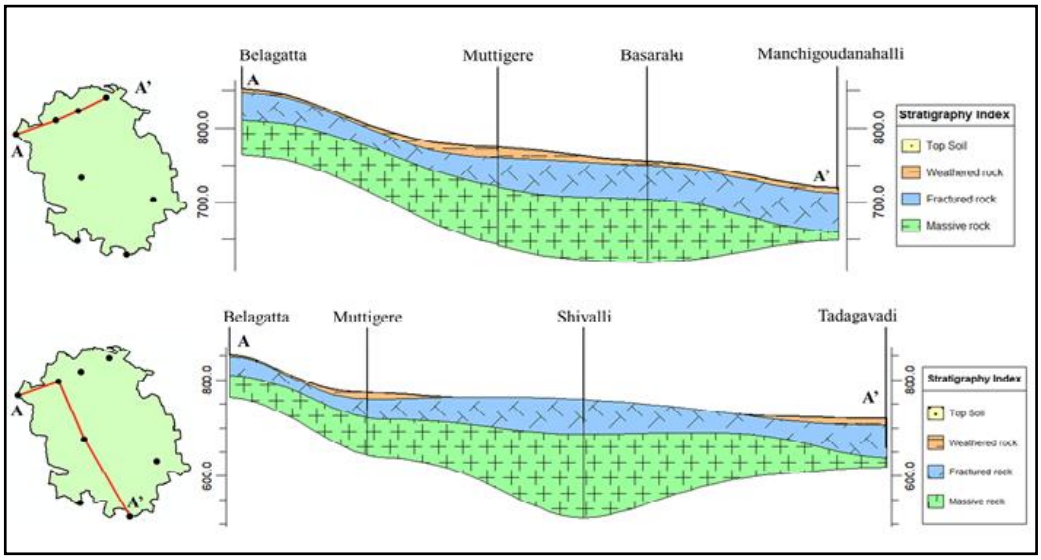

Fig. 13 (a) 2D Aquifer cross-section

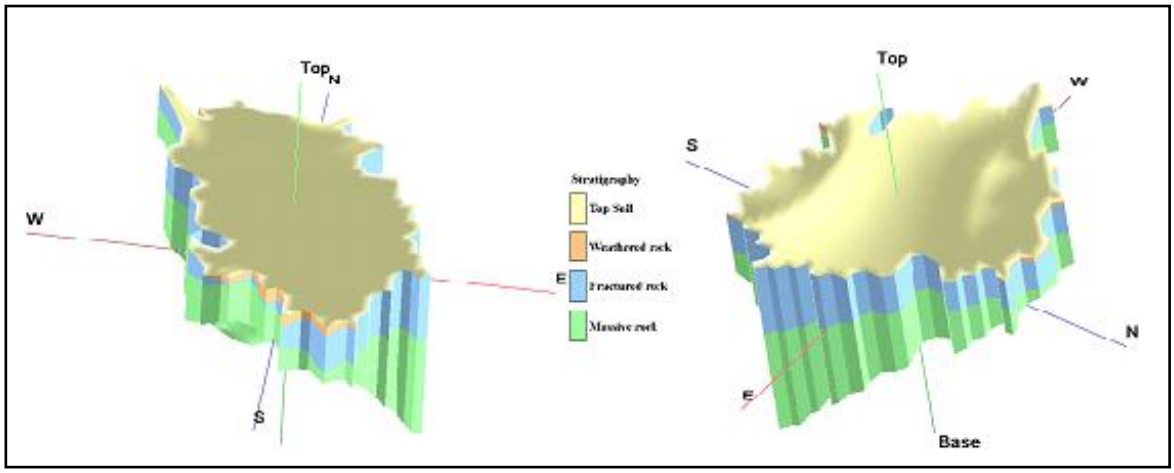

Fig.13 (b) 3D Aquifer disposition

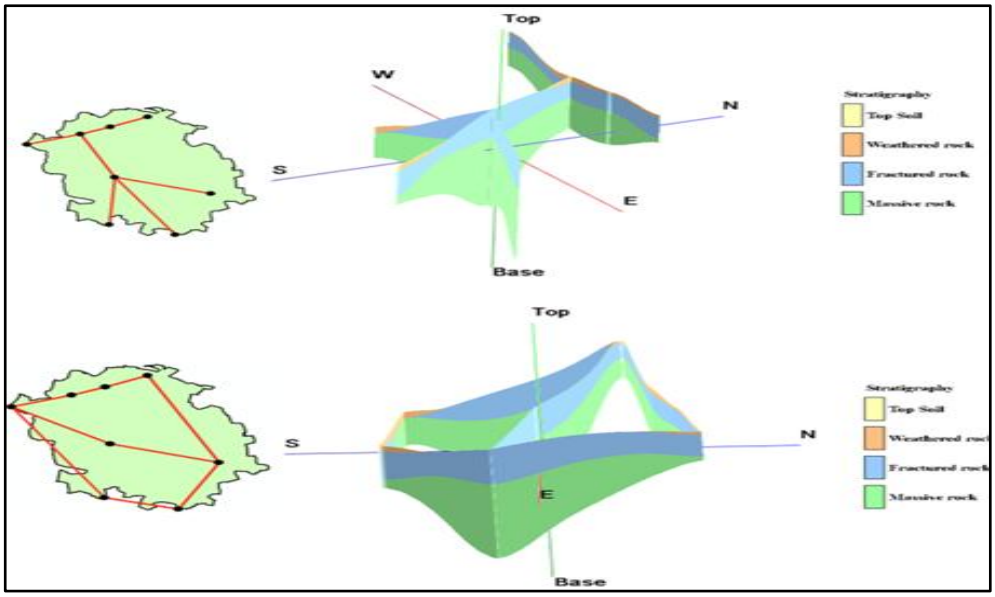

Fig.13(c): 3D Aquifer Fence Diagram

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

3.1 Aquifer wise groundwater resource availability and extraction

The ground water resource as on 2017 and as on 2020 are shown in **Table.10.** The comparison of groundwater availability and draft scenario between 2017 and 2020 is presented in **Table.11.**

Table 10: Present Dynamic Ground Water Resource (ham) in Mandya taluk

Assessment year	Net annual ground water Availability	Existing gross ground Water draft for irrigation	Existing gross ground Water draft for domestic And industrial water supply	Existing gross ground Water draft for all uses	Allocation for domestic And industrial use for next 25 years	Net ground water Availability for future Irrigation development	Existing stage of ground Water development %	Category
As on March 2017	11242	4638	351	4989	773	5980	**44**	**Safe**
As on March 2020	13023	5374	803	6177	869	6780	**47**	**Safe**

Table 11: Comparison of groundwater availability and draft scenario (in ham)

2017			**2020**		
GW availability	**GW Extraction**	**Stage of GW development**	**GW availability**	**GW Extraction**	**Stage of GW development**
11242	4989	**44**	13023	6177	**47**

From the above Table, it is seen that the stage of ground water extraction remained more or less in the same level between 2017 and 2020 with **44%** and **47%** respectively.

3.2 Chemical quality of ground water and contamination

To evaluate the quality of ground water, twowater samples were collected from the exploratory well drilled during February 2022and wereanalyzed for major chemical constituents at chemical laboratory in CGWB, SWR, Bangalore. Suitability of ground water for domestic purposes was evaluated with the concentration ranges recommended by IS: 10400, BIS, 2012 and ICMR drinking water standards and is presented in **Table-12**.

Water samples from various Panchayats of Mandya taluk are also collected during February 2021 and are analysed for major chemical constituents at chemical laboratory in CGWB, SWR, Bangalore. The results are given in **Table 13** and the water quality maps are shown in **Fig. 14.**

Table 12: Hydro chemical data of Mandya Exploratory well by CGWB

Sl. No	Constituents	Concentration Exploratory well		BIS		ICMR
		Zone I	PYT	Desirable	Permissible	
1	pH	8.52	8.6	6.5-8.5	6.5-8.5	7-8.5
2	TH(as $CaCO_3$)	120	110	300	600	300
3	Calcium mg/l	38	30	75	200	75
4	Magnesium mg/l	6.05	8.47	30	100	50
5	Chloride mg/l	163	170	250	1000	200
6	Sulphate mg/l	103	110	200	400	200
7	Nitrate mg/l	24	27	45	100	20
8	Sodium mg/l	228	325.5	-	-	-
9	Potassium mg/l	0.45	3	-	-	-
10	Carbonate mg/l	51	342	-	-	-
11	Bicarbonate mg/l			-	-	-
12	EC µmhos/cm	1422	1485	-	--	-
13	Fluoride mg/l	0.76	0.67	1.0	1.5	1.0

Table 13: Chemical analysis result of samples collected from Mandya Taluk

Sl. No.	SITE_NAME	LAT	LONG	PH	EC µS/cm	TH	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F
						<.....mg/L.....>										
1	Hollalu	12.5483	76.8583	8.55	1050	518.03	22	27	152.37	8.96	18	430	64	15	42.36	0.5
2	Kadenahalli	12.5075	76.8369	7.99	860	421.24	71	18	68.52	4.29	0	307	60	49	41.74	0.44
3	Kothathi	12.4733	76.86	8.50	660	276.13	46	29	26	1.59	21	246	21	11	46.78	0.44
4	Bevinahalli	12.4858	76.8691	7.69	2520	1347.27	168	47	271.23	41.30	0	626	344	169	47.22	0.6
5	Shivalli	12.5858	76.8247	8.04	1360	714.58	121	35	100.06	11.98	0	246	213	113	45.05	0.6
6	Dudda	12.6072	76.7961	7.96	1660	1295.18	139	89	224.4	61.10	0	632	330	142	36.93	0.77
7	Bevakallu	12.6111	76.7738	8.29	1950	1030.11	95	113	108.16	18.39	0	344	330	197	22.33	1.1
8	Mudagandoor	12.648	76.8091	8.46	1550	700.8	73	92	84.32	10.96	15	448	142	64	46.14	1.5
9	Muthegere	12.6886	76.778	8.12	1700	883	48	55	184.95	78.45	0	540	177	75	46.51	0.45
10	Basarallu	12.7072	76.8263	8.15	1290	607.56	40	90	75.17	7.60	0	571	60	55	31.49	0.48
11	Kambadahalli	12.733	76.8177	8.39	1690	880.83	36	47	186.23	67.70	27	510	177	90	43.26	0.58
12	Baby	12.6897	76.8377	8.07	1600	858.11	107	24	188.23	16.70	0	282	220	164	42.29	0.24
13	Uapakarahalli	12.6502	76.8494	7.87	880	421.83	38	47	64.49	6.97	0	313	60	52	49.65	0.18
14	B Hosur	12.6119	76.8725	8.38	1480	803.91	51	35	171.25	65.40	39	374	163	96	15.06	0.34
15	Keragodu	12.6344	76.9122	8.44	2280	1255.53	145	45	188.7	140.45	36	362	337	186	48.68	0.16
16	Hodagatta	12.6361	76.9547	7.78	1870	1011.06	145	73	103.54	5.12	0	160	401	205	25.31	0.32
17	Ummadahalli	12.5644	76.9308	8.10	980	463.03	46	32	102.36	12.34	0	417	43	23	44.94	0.46
18	Budanur	12.5472	76.9586	8.35	2240	1167.7	188	36	160.34	118.52	18	516	340	54	45.52	0.21
19	Belur	12.5469	76.9475	8.24	1050	540.55	71	52	48.76	3.50	0	221	156	101	16.76	0.23
20	Sunuganahalli	12.5105	76.9533	8.33	1580	747.83	40	113	94.23	15.20	30	460	145	85	44.94	0.39

The **Electrical Conductivity** in water samples is an indication of total dissolved ions. Thus, higher the EC, the higher the levels of dissolved ions in the sample. The perusal of the data indicates that the distribution of electrical conductivity in the taluk shows wide variations (660-2520 µS/cm at 25˚ C). The BIS has recommended drinking water standard for total dissolved solids a limit of 500mg/l (corresponding to about EC of 750 µS/cm at 25^0C) which can be extended to a TDS of 2000mg/l (corresponding to about 3000 µS/cm at 25^0C) in case of an alternate source. Water samples having TDS more than 2000mg/l are not suitable for drinking purpose**.**

One of the essential elements for maintaining normal development of healthy teeth and bones is **Fluoride**. Lower concentrations of fluoride usually below 0.6mg/l may contribute to dental caries. However, continuing consumption of higher concentrations, above 1.5 mg/l however cause dental fluorosis and in extreme cases even skeletal fluorosis. Most of the fluoride found in groundwater is of geogenic origin. Distribution of fluoride in the taluk ranges from 0.16 mg/l to 1.5 mg/l. Thus, majority of samples in the taluk shows fluoride concentration below 1.5 mg/l rendering them suitable for drinking purpose**.**

Nitrate is a problem as a contaminant in drinking water (primarily from groundwater and wells) due to its harmful biological effects. High concentrations can cause methemoglobinemia, and have been cited as a risk factor in developing gastric, an intestinal cancer. The distribution of nitrate in the taluk indicated that the values are in the range of 15.06 mg/l to 49.65 mg/l. Nitrate in drinking water should not exceed 45 mg/l as per BIS (ISO: 10500: 2012) standard**.**

In addition to this, chemical analytical data of dugwells/borewells samples collected by Ground Water Directorate, Govt. of Karnataka during 2018-19 from Mandya Taluk is also presented in the following **Table 14**. The ground water quality maps (EC, Fluoride and Nitrate) are presented in Fig.14. **Photo.3** shows the ground water sample collection during the field study.

Table 14: Hydro chemical data of dugwells/borewells in Mandya taluk

Location	Concentration in mg/L			Latitude	Longitude
	F mg/L	NO_3 mg/L	TH (as $CaCO_3$) mg/L		
Javanahalli	0.77	6	328	76.7441	12.6395
Pura	0.32	22	220	76.9366	12.4694
Biledegalu	0.47	89	644	76.8718	12.6247
Baby	1.16	9	332	76.8513	12.6842
Toobinakere	0.8	3	344	76.7973	12.4952
Mandya	0.67	22	400	76.8983	12.5257
Bevakallu	0.47	125	652	76.7734	12.6113
Lingamannahalli	0.67	1	448	7640 13	123410

Alternate Source*Source: GWD. Govt. of Karnataka*

Not Potable

Photo.3.Water sample collection for chemical Analysis

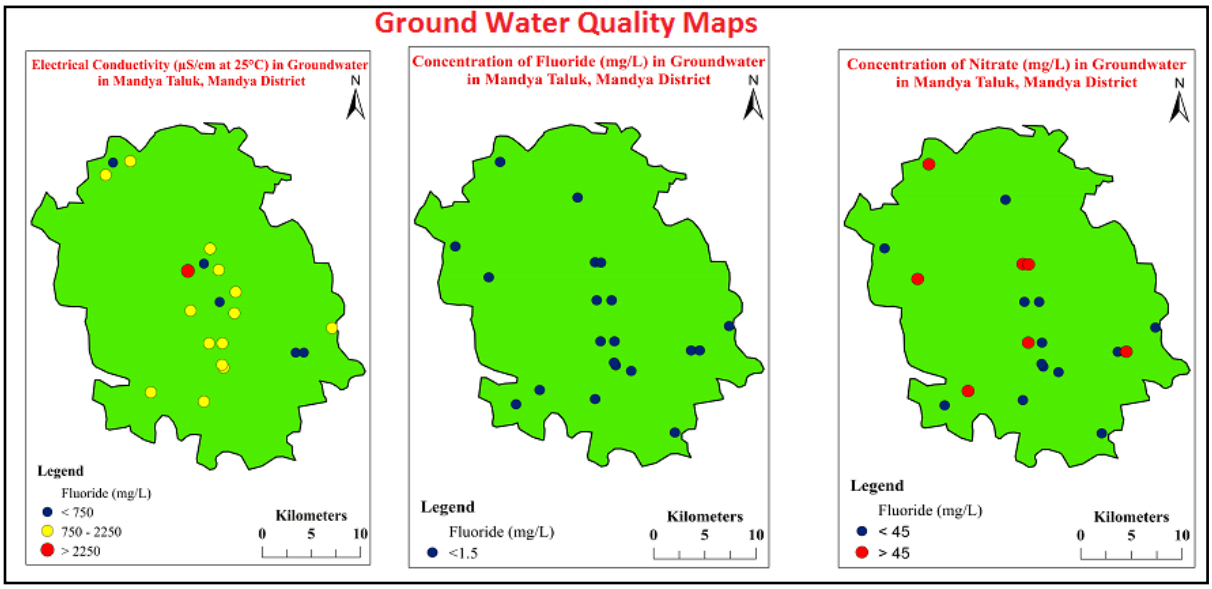

Fig. 14: Water Quality maps of Mandya taluk

4. GROUND WATER RESOURCE ENHANCEMENT

4.1 Resource Enhancement by Supply Side Interventions

The Master Plan for Artificial recharge to ground water prepared by CGWB (2020) recommendedto recharge the de-saturated and dried-up phreatic aquifer (Aq-I) in the taluk, through construction of artificial recharge structures such as Check dams and Point recharge Structures **(Table.15).**The choice of recharge structures should be site specific and such structures need to be constructed in areas already identified as feasible for artificial recharge. Area feasible for artificial recharge in Mandya taluk is shown in **Fig.15.**

Table 15: Quantity of non-committed surface runoff and expected recharge through AR structures proposed

MandyaTaluk	
Area Feasible for Artificial Recharge	108sq km
Non committed monsoon runoff available (Ham)	3.699
Number of Check Dams	7
Number of Point Recharge Structures	3
Number of Percolation Tanks	-
Number of Sub Surface Dyke	-

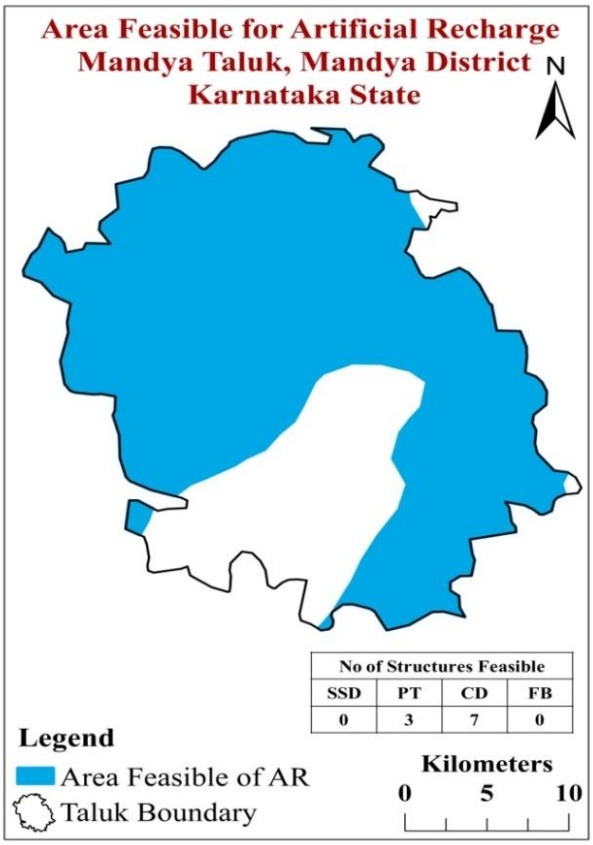

Fig.15: Area feasible for Artificial Recharge Structures

4.2 DEMAND SIDE INTERVENTIONS

4.2.1 Advanced irrigation practices

The important crops grown in the taluk are Paddy, Pulses, Jowar, Oilseeds, Maize, and Sugarcane. Presently, major portion of the net area irrigated (about 78% is being met by surface water from canals, and about 13% is contributed by ground water (Source: District at a Glance 2015-16 and CADA 2021). Hence, Water Use Efficiency (WUE) practices like Drip is recommended in areas being irrigated by ground water. This will save irrigation water by way of precision farming mechanism. This ultimately enhances the area under irrigation potential. Details are worked out and shown in **Table.16.**

4.2.2 Change in cropping pattern

Farmers are facing inadequacy of groundwater for agriculture during summer and can opt for more rain-fed millets and water efficient Pulses for agricultural production.

Table 16: Details of Resource Enhancement after proposed artificial Recharge

Sl. No.	**Resource Details**	**As per 2020 Estimation**
1	Net Ground Water Availability in Ham	13023
2	Existing ground water draft for all uses in Ham	6177
3	Existing Stage of Ground Water Development in percentage %	47
4	Expected Recharge from Artificial Recharge sources in ham	277
5	Cumulative Ground water availability in Ham	13300
6	Saving due to adopting Water Use Efficiency in Ham	1074
7	Ground water availability after WUE in Ham & AR	14374
8	Expected improved stage of ground water development after implementation of WUE % and AR	43%
9	Cumulative improved stage of ground water development after all implementation %	**4%**

4.2.3 Regulation and Control

- As per the resource estimation – 2020, Mandya taluk falls under **Safe** category with the stage of ground water extraction of **47%**. However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority needs to be strictly implemented in the taluk, so that quality of ground water will improve in due course of time.

4.2.4 Ground Water Development Plan

In Mandya taluk, the present stage of ground water extraction (2020) is 47% with net ground water availability for future use is 6780 ham and total extraction is 6177ham (2020) The ground water draft for irrigation purpose is 5374 ham, thus indicating that ground water irrigation needs to be encouraged in the area after considering the “Safe” level of extraction of 70%. For this, it is imperative to have a robust ground water resource development plan for the area, which can be implemented in scientific manner. The implementation of the plan needs to be based on site specific detailed hydrogeological, geophysical and scientific surveys for pinpointing the sites for construction of dug wells and bore wells.

As per the conservative estimate and after considering the average unit draft figure for the taluk, about 400 dug wells (10-15 m depth; 3 to 5 m diameter) are recommended to be constructed in feasible areas. Further. as per the estimate about, 2000 borewells (100 to 200 m depth; 150 mm

dia) are also recommended to be drilled in feasible areas so as to maintain the safe category of the taluk. The likely additional irrigation potential which can be created considering prevailing crop water requirement for the area is will be 2880 ha.

4.2.5 Conjunctive use plan in water logged area

About 78% of the taluk area is covered by canal command area of Krishnarajasagar project. Out of this, an area of 1651 ha.is water logged, out of which 9 ha is reclaimed and 1642 ha. is yet to be reclaimed (Source: CADA as on March 2021). In addition to this reclamation, conjunctive use plan is also recommended to benefit the water deficit and tail end area of the irrigation command.

4.2.6 Other interventions proposed

- Remedial measures need to be adopted in the areas affected by Nitrate and EC rich groundwater through artificial recharge and water conservation etc.
- The choice of recharge structures should be site specific and such structures need to be constructed in areas already identified as feasible for artificial recharge.
- Periodical maintenance of artificial recharge structures should be incorporated in the Recharge Plan.
- Augmenting surface water supply from Cauvery River.
- Intense monitoring of water level is recommended to keep an eye on water level trend in the Taluk.
- Awareness programmes and practice of participatory approach needs to be strengthened with the involvement of all the stake holders for sustainable management.

5. SUMMARY AND RECOMMENDATIONS

The main ground water issues are Limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, Deeper Water Levels particularly in Aquifer-II in some parts, Inferior Ground Water Quality due to nitrate contamination in some pockets and water logging in canal command area.

Table 17: Summary of Management plan

Stage of GW Extraction and Category (2020)	47 %, Safe
Annual Extractable GW Resource (Ham)	13023
Total Extraction (Ham)	6177
Ground Water Draft for Irrigation (Ham)	5374
Ground Water Resource Enhancement by Supply side Interventions	
No of Proposed AR structures SSD PT CD Filter Beds	 0 3 7 0

Expected Additional Recharge to GW due to AR (Ham)		277
Ground Water Resource Savings by Demand side Interventions		
Expected Saving due to adopting WUE (Ham)		1074
Change in Stage of GW development (%)		47 to 43
Ground Water Quality – Nitrate contamination	Improving quality by proper drainage of sewage and Limited usage of Nitrogenous fertilizers	

As per the resource estimation – 2020, Mandya taluk falls under Safe category with the stage of ground water extraction 47%. However, there is need to formulate management strategy to tackle the water scarcity related issues and nitrate contamination in the taluk. It is suggested to adopt a scientific and multi-pronged ground water management strategy covering supply side and demand side interventions aspects as mentioned in the management plan suggested above.

Ground water resource enhancement by supply side interventions: Quantity of surface water available through non-committed surface run-off is estimated to be 3.699 MCM. This can be used to recharge the aquifer through Percolation tanks (3) and Check dams (7). The volume of water expected to be recharged is 277 ham through these AR structures. The approximate cost estimate for construction of these AR structures is Rs.135.855 lakhs. However, the figures given are tentative and pre-field studies / DPR are recommended prior to implementation of these recharge structures.

Ground water resource enhancement by demand side interventions: The important crops grown in the taluk are Paddy, Pulses, Jowar, Oilseeds, Maize, and Sugarcane. Presently, major portion of the net area irrigated (about 78% is being met by surface water from canals, and about 13% is contributed by ground water (Source: District at a Glance 2015-16 and CADA 2021). Hence, Water Use Efficiency (WUE) practices like Drip is recommended in areas being irrigated by ground water. This will save irrigation water by way of precision farming mechanism. This ultimately enhances the area under irrigation potential.